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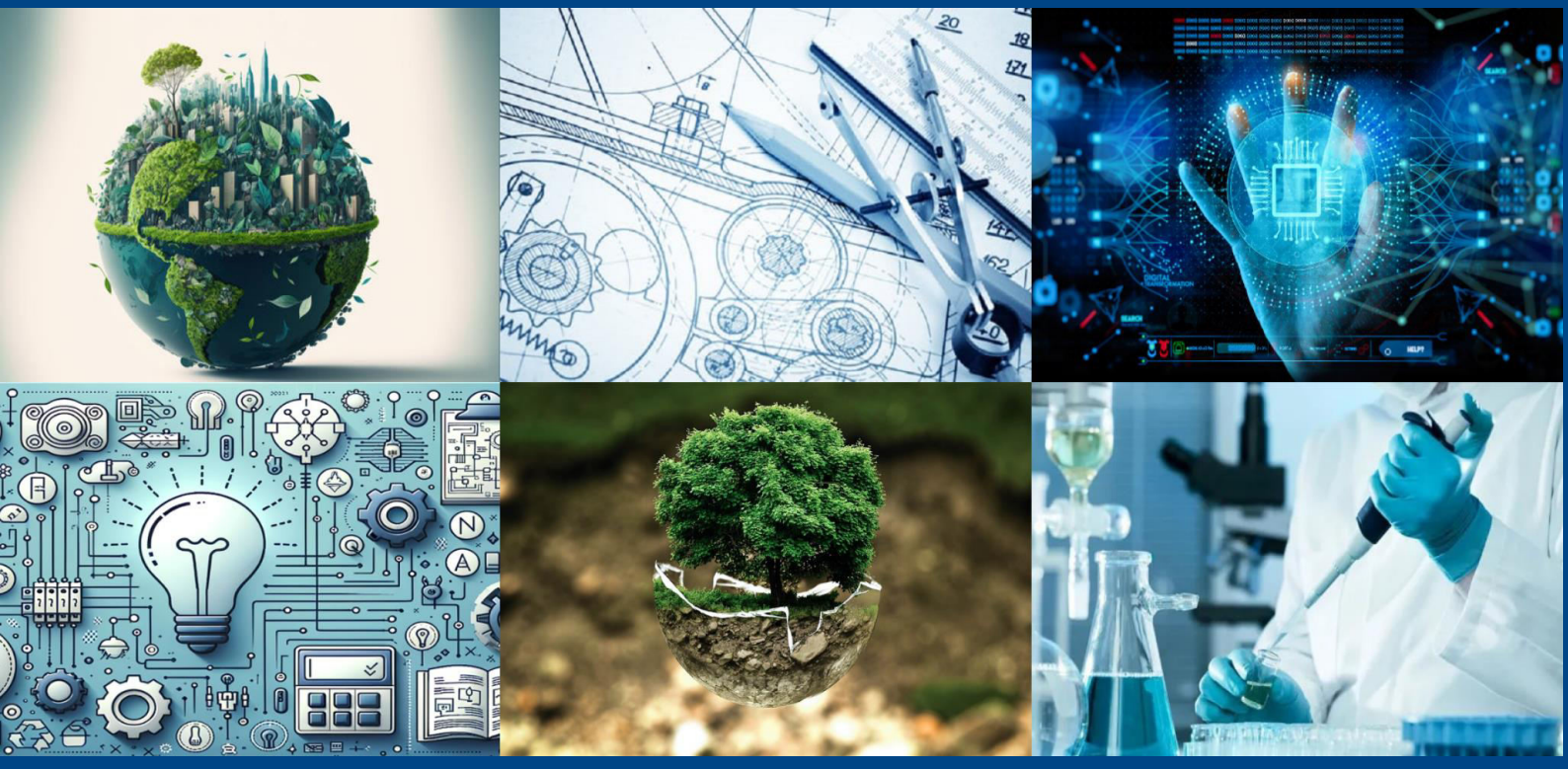

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LPG Leakage Detection System

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ABSTRACT: Liquefied Petroleum Gas (LPG) is a main source of fuel, especially in urban areas because it is clean compared to firewood and charcoal. Gas leakage is a major problem in the industrial sector, residential premises, etc. Nowadays, home security has become a major issue because of increasing gas leakage. Gas leakage is a source of great anxiety with ateliers, residential areas and vehicles like Compressed Natural Gas (CNG), buses, and cars which are run on gas power. One of the preventive methods to stop accidents associated with the gas leakage is to install a gas leakage detection kit at vulnerable places. The aim of this paper is to propose and discuss a design of a gas leakage detection system that can automatically detect, alert and control gas leakage. This proposed system also includes an alerting system for the users. The system is based on a sensor that easily detects a gas leakage.

I. INTRODUCTION

Gas leakage is a serious problem increasingly observed in various settings such as residences, industries, and vehicles like Compressed Natural Gas (CNG) buses and cars. Such leaks often lead to dangerous accidents. Liquefied Petroleum Gas (LPG), commonly used as a fuel in homes, hostels, industries, and automobiles, is a flammable mixture of hydrocarbon gases, primarily propane and butane. These gases are preferred for their high calorific value, low smoke output, minimal soot production, and relatively lower environmental impact. However, LPG is highly inflammable and capable of igniting even at a distance from the leakage source. In households, LPG is mainly used for cooking, and any leak can result in catastrophic explosions. Gas leakage accidents not only cause substantial material damage but also pose serious risks to human life, including injuries and fatalities. The frequency of home fires and associated threats has been on the rise in recent years. The risk factors such as explosion, fire, and suffocation are attributed to the physical properties of the gas, including its flammability and toxicity. Moreover, the increasing number of deaths due to gas cylinder explosions highlights the urgency of this issue. Factors contributing to such incidents include the use of substandard cylinders, outdated valves, lack of regular inspections, worn-out regulators, and inadequate public awareness about safe gas cylinder handling. A tragic reminder of the dangers of gas leakage is the Bhopal gas tragedy, underscoring the need for effective leakage detection systems.

II. LITERATURE SURVEY

Several researchers and developers have recognized the increasing threat of LPG leakage and have proposed various systems and technologies to detect and prevent such hazardous incidents. The literature reveals a broad range of solutions incorporating gas sensors, microcontrollers, IoT technologies, and communication modules to build reliable LPG leakage detection systems.

A system was proposed using an MQ-6 gas sensor with an Arduino microcontroller. The sensor detects LPG concentration in the air, and upon crossing a threshold value, it triggers a buzzer alarm and activates an exhaust fan. This system was simple, cost- effective, and provided real-time alerts but lacked long-distance communication features. Researchers developed an IoT-based gas leakage detection and alert system using NodeMCU and Blynk App. The system not only sounded a local alarm but also sent notifications to the user's smartphone. This improved remote

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monitoring and control, allowing users to take timely action even when not at home.
A GSM module was integrated with the gas detection system. When a leak was detected, the system automatically sent SMS alerts to the user and nearby authorities. This approach demonstrated the effectiveness of SMS-based communication, especially in areas with limited internet access. Machine learning algorithms were used to predict and detect gas leakage more accurately. By analyzing patterns in sensor data, false alarms could be reduced significantly. However, this system required a larger dataset and more processing power. Researchers explored the implementation of automated gas shut-off valves that work in sync with the gas detection system. As soon as a leak is identified, the main gas supply is cut off to prevent further leakage, thus reducing the risk of explosion. The literature also highlights the use of Zigbee, Wi-Fi, and LoRa communication technologies to enhance the system's connectivity and scalability. Studies suggest that combining multiple sensors and integrating cloud storage for historical data analysis can improve system accuracy and enable predictive maintenance.

Overall, previous works indicate a strong emphasis on safety, automation, and remote accessibility. However, many of the existing solutions still face challenges such as sensor calibration, false positives, power consumption, and cost-efficiency. Therefore, there is a continuous need to improve LPG leakage detection systems to make them more reliable, affordable, and widely deployable.

III. PROBLEM STATEMENT

Liquefied Petroleum Gas (LPG) is widely used as a primary fuel source in households, industries, and vehicles due to its high efficiency and clean-burning properties. However, its highly flammable nature poses a significant risk of fire, explosion, and suffocation in the event of a leak. Incidents of LPG leakage have resulted in numerous accidents, causing extensive damage to property, loss of life, and long-term health hazards. These risks are further exacerbated by factors such as poor-quality gas cylinders, aging infrastructure, lack of proper maintenance, and inadequate user awareness.
Despite the growing demand for safety measures, many existing gas detection systems are either too expensive, lack portability, or require complex installation and maintenance. Moreover, traditional detection mechanisms often fail to provide timely alerts or remote monitoring capabilities, making them less effective in preventing accidents, especially in residential and small-scale commercial settings.

The **LPG Leakage Detection System** project aims to tackle these challenges by designing a low-cost, efficient, and user-friendly device capable of detecting gas leaks in real-time. The system will use reliable gas sensors and microcontroller-based technology to trigger immediate alerts through buzzers, LEDs, and potentially SMS or IoT-based notifications. This solution is intended to enhance safety by enabling early leak detection and rapid response, thereby reducing the risk of fire-related disasters and promoting safer handling of LPG.

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IV. METHODOLOGY USED

4.1 CIRCUIT DIAGRAM

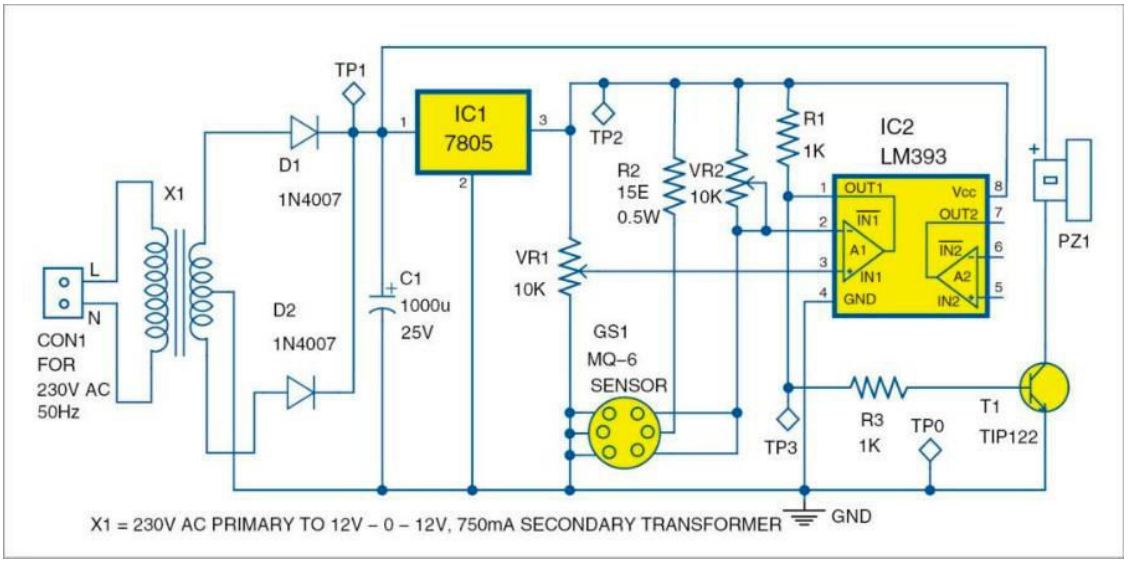

Fig. 4.1 Circuit Diagram

The MQ6 gas sensor has a high sensitivity to Propane, butane and LPG, and response to Natural gas. The sensor could be used to detect different combustible gasses, especially Methane; it has a low cost and is suitable for different applications. The MQ-6 can detect gas concentrations anywhere from 200 to 10,000 ppm. The sensor's output is an analog resistance. Figure above shows the block diagram of the gas leakage detection and alert system. This system is based on the Arduino UNO R3 and MQ-6 gas sensor.

When the sensor detects gas in the atmosphere, it will give digital output 1 and if gas in not detected the sensor will give digital output 0. Arduino will receive the sensor output as digital input. If the sensor output is high, then the buzzer will start tuning along with the LCD that will show that "Gas detected: Yes". If the sensor output is low then buzzer will not be tuning, and the LCD will show that "Gas detected: No". The buzzer most commonly consists of a number of switches or sensors connected to control unit that determines which button was pushed or whether a preset time has lapsed, and usually illuminates a light on the appreciate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound.

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4.2 COMPONENTS REQUIRED

S.NO	EQUIPMENT	QUANTITY
1.	ARDUINO	1
2.	MQ-6 GAS SENSOR	1
3.	16*2 LCD	1
4.	BUZZER	1
5.	10 K V ARIABLE RESISTOR	1
6.	MALE TO MALE/FEMALE WIRE	40
7.	GAS LIGHTER	1
8.	9V BATTERY / CHARGER TO GIVE SUPPLY	1
9.	ATMEGA328P	1

The LPG Leakage Detection System is designed using a combination of sensors, microcontrollers, and display units to provide an efficient and real-time alert mechanism in case of gas leakage. At the core of this system is the **MQ6 gas sensor**, which is capable of detecting LPG and butane gases. The sensor operates by changing its internal resistance based on the gas concentration in the environment and outputs both analog and digital signals. These outputs are then interpreted by a microcontroller—**Arduino Uno** in this case.

The **Arduino Uno**, a user-friendly and low-cost microcontroller, is responsible for processing sensor data and triggering outputs such as buzzers or displays. A **16x2 LCD display** is used to provide a visual alert and display gas levels in real-time. This LCD operates using either an 8-bit or 4-bit data interface and is controlled via command and data registers. The system is modular, making it easy to implement and integrate with other safety systems. By using sensor calibration and threshold values, this setup ensures accurate gas detection and timely alerts, thereby preventing hazardous situations.

V. ADVANTAGE & DISADVANTAGE

Advantages of the LPG Leakage Detection System:

1. **Early Detection**: Quickly identifies gas leaks before they become hazardous, helping to prevent accidents and explosions.
2. **Low-Cost Implementation**: Utilizes affordable components like the MQ6 sensor and Arduino, making the system cost-effective.
3. **Compact and Portable**: The system is small and easy to install in homes, vehicles, or industrial areas.
4. **Real-Time Alerts**: Provides immediate notification through alarms or displays, allowing for fast response.
5. **Energy Efficient**: Operates on low power, suitable for battery-powered or continuous operation.
6. **User-Friendly**: Simple circuit design and interface allow easy usage and maintenance, even for non-technical users.
7. **Scalable and Customizable**: Can be expanded or integrated with IoT, GSM modules, or mobile apps for remote alerts.

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Disadvantages of the LPG Leakage Detection System:

1. **Sensor Degradation Over Time**: The MQ6 sensor may lose sensitivity after prolonged use, requiring replacement.
2. **Limited Gas Detection Range**: Typically focused on LPG and similar gases; not suitable for detecting all types of hazardous gases.
3. **False Alarms**: May trigger alarms due to smoke, alcohol, or other gases if not properly calibrated.
4. **Maintenance Required**: Periodic sensor calibration and testing are necessary to ensure consistent performance.
5. **No Auto Shutdown Feature**: Basic models may not have automatic control to cut off gas supply during a leak.
6. **Environmental Interference**: Temperature, humidity, and ventilation can affect sensor readings.
7. **Power Supply Dependency**: The system may fail to function during power outages unless backed by batteries.

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